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EFFECT OF BIOAEROSOL ON THE RELEASE OF IODINE FROM IODINE TREATED FILTERS

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14. ABSTRACT

A series of experiments were run with salt aerosols to test an hypothesis that the surface charge on the particles promotes displacement of I2 from poly(4-trimethylammoniummethylstyrene triiodide). At attainable concentrations of aerosol measured particle counts were too small to verify the hypothesis.

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1. Introduction

The objective of this study was to determine the effect of bioaerosol on release of iodine from a filter treated with poly(4-[trimethylammoniummethyl]styrene triiodide) (PTSI). The hypothesis, proposed in prior studies (Ratnesar-Shumate et al., 2008; Lee et al., 2009), is that near contact with the negative charge on the bioaerosol will induce release of iodine. However, no experiment has previously been conducted to prove it. To verify the hypothesis, negatively charged MS2 was treated with or without charge neutralization and then passed through a PTSI-treated filter medium. In control experiments, DI water was nebulized as the baseline condition.

2. Experimental Methods:

2.1. Test Agent:

MS2, an *Escherichia coli* bacteriophage, (ATCC ®15597-B1™) investigated in previous tests of iodinated filters, was used as the biological test agent. It has a single-stranded RNA genome and an approximate diameter of 28 nm (Prescott et al., 2002; Golmohammadi et al., 1993). MS2 is hydrophilic and negatively charged (Valegård et al, 1990).

2.2. Experimental system

Figure 1 shows a schematic of the experimental system. Bioaerosols were generated by a six-jet Collison nebulizer at 7 Lpm. Virus concentrations in the Collison nebulizer of 10^5–10^6 PFU mL^{-1} were prepared by diluting 0.10 or 0.20 mL of virus stock suspension in 50 mL sterile DI water. The bioaerosol flow was then joined by a dry dilution flow (8 Lpm) in a dilution dryer. The combined flow then passed through a ^{85}Kr charge neutralizer (TSI, 3012A). A thermometer and a relative humidity (RH) meter, respectively, measured temperature and RH of the air stream. The temperature was 23~24 °C, and RH was 44–46%. The pressure drop of the test filter was measured using a Magnehelic pressure gauge. Penetrating bioaerosol was collected by an SKI Biosampler that used 15 mL of phosphate-buffered saline (PBS) as the collection liquid. Sampling was conducted for 60 min. There were eight sets of experiments. To ensure clearance of residual virus or medium from previous runs, the system was flushed with DI water for 30 min after each experiment. In addition, each piece of PSTI-treated filter was used for only one set of experimental conditions. Table 1 lists the experimental conditions.

2.3. Iodine Analysis:

The concentration of I_2 collected in the biosampler medium was analyzed by the *N*,*N*-diethyl-*p*-phenylenediamine (DPD) colorimetric method adopted from *Standard Methods for the Examination of Water and Wastewater 4500-CI G* (APHA 1995). I_2 in the solution reacts

with DPD to form a pink color, the intensity of which is proportional to the total I_2 concentration (HACH 2003; Lee et al., 2009). Ten mL of the collection medium was analyzed at a wavelength of 530 nm using a DR/4000 V spectrophotometer (HACH, Loveland, CO, USA). The detection limit of this spectrophotometer using HACH Program: 2100 provided in the spectrometer for iodine is reported by the manufacturer to be 0.04 mg/L I_2.

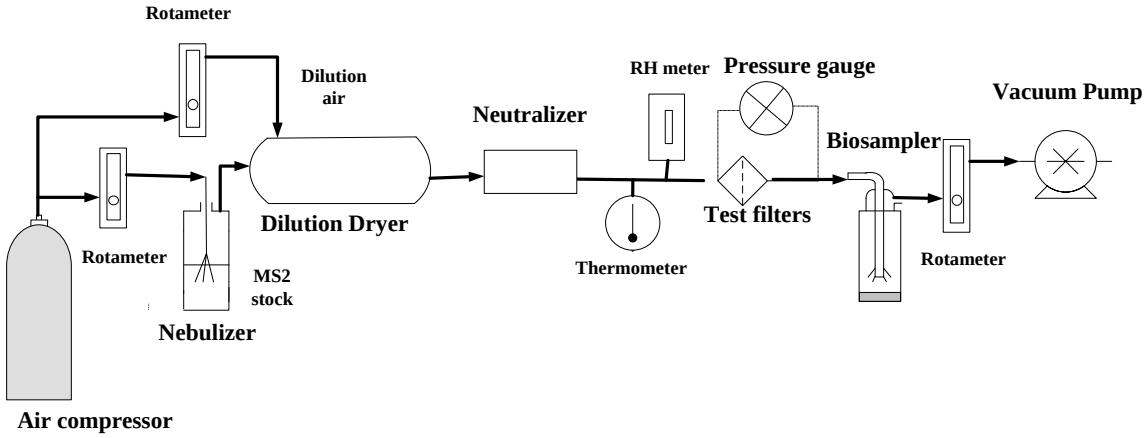

Figure 1. Experimental System

3. Results:

Figure 2 shows the size distribution of the feed aerosol. The mode size was ~30 nm, which is similar to the size of a single MS2 virus and agrees with prior studies using MS2 aerosol (Hogan et al., 2005; Burton et al., 2007; Richardson et al., 2006).

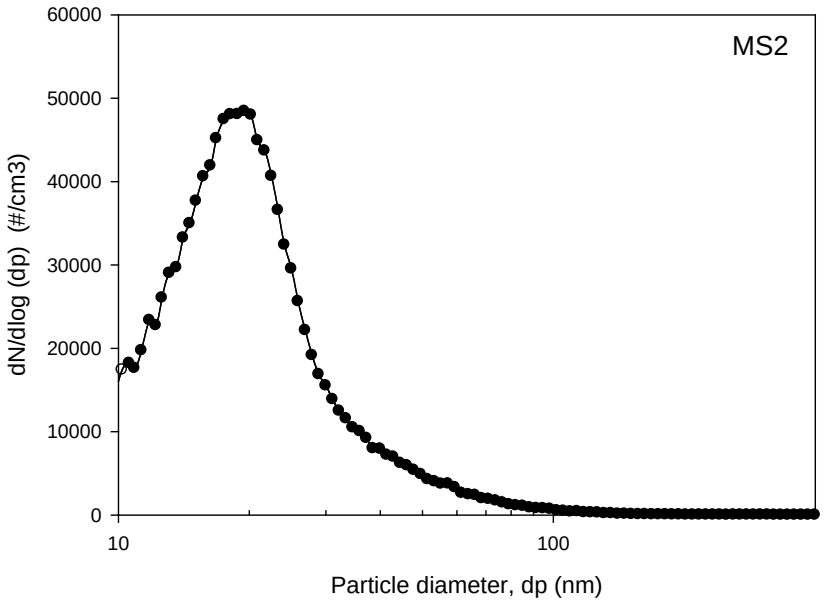

Figure 2. Representative particle size distribution of produced MS2 aerosol

The calibration curve of this spectrophotometer using HACH Program: 2100 with the DPD method was established; the R^2 value was 0.9992 as shown in Figure 3. The iodine concentration of each test and its corresponding experimental condition are shown in Table 1. The pressure drop of iodine-treated filters was 2.4~2.5 in H_2O. There was no change in pressure drop across the filter medium through the entire course of experiments.

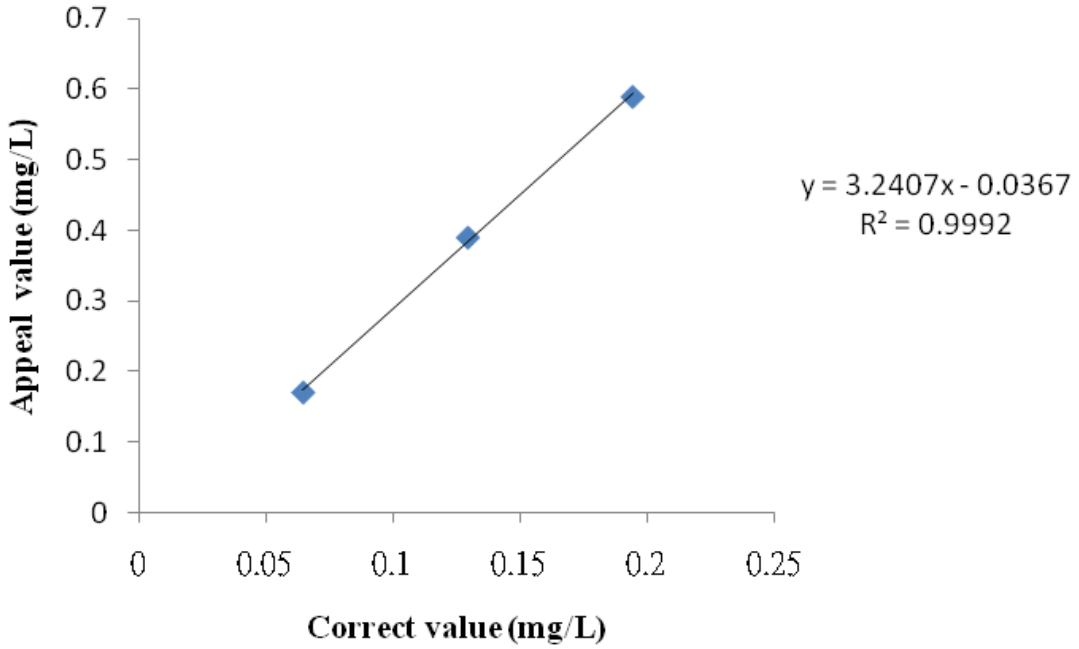

Figure 3. Calibration Curve for the Spectrometer

For the baseline experiment (DI water) without and with the test filter, concentrations were 0.014 mg/L and 0.024 mg/L, respectively. When bioaerosol was introduced, the concentration was 0.017 mg/L in the absence of the iodinated filter, while the concentration was 0.027–0.030 mg/L with the iodinated filter. The use of a charge neutralizer had no observable effect on the result. However, the data were very close to the detection limit (0.04 mg/L). Therefore, no conclusion can be drawn from the results to demonstrate any significant effect of MS2 bioaerosol on the release of iodine from the iodine-treated filter medium.

Table 1. Iodine concentrations Measured at Various Experimental Conditions

No	Sample	T (°C)	RH (%)	Pressure Gauge (in H_2O)	PSTI-Treated Filter	Charge Neutralizer	I_2 conc. (mg/L)
1	Blank (DI water)	-	-	-	-	-	**0**
2	1XPBS	-	-	-	-	-	**0**
3	Standard solution-1	-	-	-	-	-	**0.0648**
4	Standard solution-2	-	-	-	-	-	**0.1296**
5	Standard solution-3	-	-	-	-	-	**0.1944**
7	DI water (50 mL)	24	45	-	No	No	**0.014**
8	DI water (50 mL)	24	44	-	No	Yes	**0.014**
9	DI water (50 mL)	23	45	2.4	Yes	No	**0.024**
10	DI water (50 mL)	24	44	2.4	Yes	Yes	**0.024**
11	DI water (50 mL) + MS2 (10 mL)	23	45	-	No	No	**0.017**
12	DI water (50 mL) + MS2 (10 mL)	24	45	-	No	Yes	**0.017**
13	DI water (50 mL) + MS2 (10 mL)	24	46	2.5	Yes	No	**0.027**
14	DI water (50 mL) + MS2 (10 mL)	24	45	2.5	Yes	Yes	**0.030**

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